CERTIFICATE OF TRANSMISSION **I hereby certify that this correspondence is being electronically transmitted to Commissioner for Patents, Alexandria, Virginia 22313, Attn: Examiner Anna M. Crowell by EFS-Web on November 13, 2006.** **/Chih-Sheng Lin/** **Dated: November 13, 2006**	Patent Attorney Docket: H37-091 DIV Firm: Notaro & Michalos P.C.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	J. Schmitt
Application No.	:	09/824,936
Filing Date	:	April 3, 2001
For	:	PLASMA REACTOR FOR THE TREATMENT OF LARGE SIZE SUBSTRATES
Examiner	:	Anna M. Crowell
Art Unit	:	1763

20 Pages
Via EFS-Web
Attn: Examiner Crowell
Mail Stop Appeal Brief-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

APPEAL BRIEF

Sir:

The present Brief is submitted in support of the Appeal in the above-identified application.

The Commissioner is hereby authorized to charge Deposit Account No. 14-1431 the amount of $500.00 for the submission of the present Brief and the Commissioner is also hereby authorized to charge Deposit Account No. 14-1431 for any additional fees which may be due under 37 C.F.R. 1.16 or 1.17.

The two month period for filing this Brief expires on November 11, 2006. Since November 11, 2006 is a Saturday, no extension of time fee is required if the Brief is filed on or before November 13, 2006.

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REAL PARTY IN INTEREST

The present application is assigned to OC OERLIKON BALZERS AG, the real party of interest.

RELATED APPEALS AND INTERFERENCES

To the best of Applicant's knowledge, no related appeal is presently pending.

STATUS OF THE CLAIMS

Claims 1, 3, 4 and 6-8, which were finally rejected by the Examiner as noted in the Final Office Action dated May 11, 2006, are being appealed.

Claims 2 and 9-12 have been withdrawn.

Claims 5 and 13-15 have been canceled.

STATUS OF AMENDMENTS

Applicant has not filed any amendments subsequent to the Final Office Action dated May 11, 2006.

SUMMARY OF THE CLAIMED SUBJECT MATTER

Claim 1 is the only independent claim on appeal.

The claimed invention is related to a capacitively coupled radio frequency (RF) plasma reactor, which is also known in the art as a parallel plate RF plasma reactor. The invention claimed in claim 1 will be described below with the use of reference numerals.

It will be understood that all reference numerals used herein are not intended to limit the scope of the claims.

Claim 1 is directed to a plasma reactor (e.g., FIG. 2, item 1) which comprises at least two electrically conductive electrodes (e.g., FIG. 2, items 3 and 5) spaced from each other. Each electrode has an external surface (e.g., FIG. 2, items 3a and 5a, and page 7, lines 9-11, of the specification). An internal process space (e.g., FIG. 2, item 13) is enclosed between the electrodes (e.g., page 2, line 27, of the specification).

The plasma reactor also includes a gas providing means (e.g., FIG. 2, item 7) for providing the internal process space with a reactive gas (e.g., page 7, lines 12-13, of the specification); at least one radio frequency generator (e.g., FIG. 2, item 9) for frequencies greater than 13.56 MHz connected to at least one of the electrodes, at a connection location (e.g., FIG. 2, item 9a), for generating a plasma discharge in the process space (e.g., page 2, lines 12-22, of the specification); and means (e.g., FIG. 2, item 8) to evacuate the reactive gas from the reactor (e.g., page 7, line 14, of the specification).

The plasma reactor is configured to process at least one substrate (e.g., FIG. 2, item 15) with a largest dimension of at least 0.7 m (e.g., page 6, lines 1-17), which defines one boundary of the internal process space, to be exposed to the processing action of the plasma discharge. The substrate extends along a general surface (e.g., FIG. 2, item 15a) and is arranged between the electrodes (e.g., page 7, lines 22-25, of the specification).

The plasma reactor further comprises at least one dielectric layer (e.g., FIG. 2, item 11) with at least one non-planar external surface (e.g., page 8, lines 1-3, of the specification) and extending outside the internal process space. The dielectric layer being a capacitor that is electrically in series with the substrate and the plasma. Preferably, the

dielectric layer has capacitance per unit surface values which are not uniform along at least one direction of the general surface (e.g., FIG. 2, item 15a), for generating a distribution profile, for compensating a process in a non-uniform manner along the general surface (15a) in the reactor (e.g., page 8, lines 4-13). FIG. 2 is of the present application is reproduced below for the Board's ease of reference.

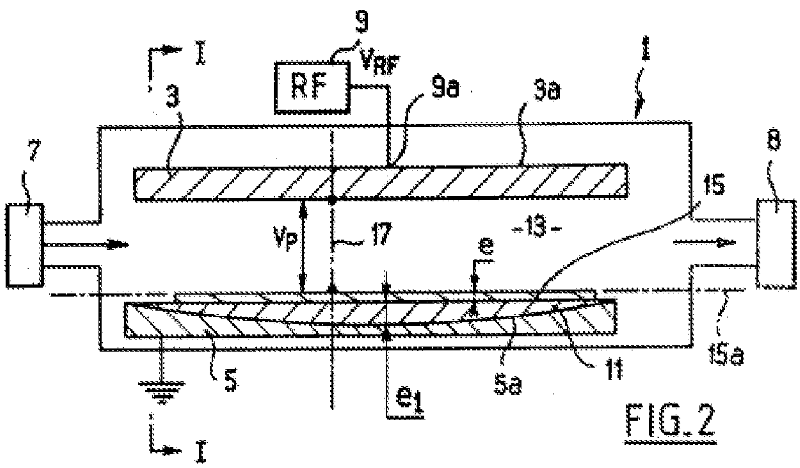

FIG. 2

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

There are two issues presented to the Board by virtue of the present appeal.

The first is whether the rejections of claims 1, 3, 4 and 6-8 under 35 U.S.C. § 103(a) as allegedly being unpatentable over the combined teachings of Hanada (Japanese Patent Publication 08-186094), Shang, et al. (US 6,177,023) and Collins, et al. (US 5,210,466) is appropriate.

The second issue is whether the rejections of claims 1, 3, 4 and 6-8 under 35 U.S.C. § 103(a) as allegedly being unpatentable over the combined teachings of Hanada, Shang and Sato, et al. (US 6,199,505) is appropriate.

ARGUMENT

The Examiner's rejections of claims 1, 3, 4 and 6-8 under 35 U.S.C. § 103(a) were not well-founded and should be reversed.

The claimed invention deals with an improved capacitively coupled radio frequency (RF) plasma reactor (also known as parallel plate RF plasma reactor) for processing large size substrates (e.g., with a largest dimension of at least 0.7m) at RF frequency greater than 13.56 MHz. See Applicant's independent claim 1.

Capacitive RF plasma reactors are typically used for exposing a substrate to the processing action of a glow discharge. Various processes are used to modify the nature of substrate surface. Depending on the process and in particular the nature of the gas injected into the glow discharge, the substrate properties can be modified such as through adding or selectively removing a thin film from the surface of the substrate. See specification, page 1, lines 11-16.

An important observation was noted especially if the RF frequency is higher than 13.56 MHz and a large size substrate is used, such that the reactor size is no longer negligible relative to the free space wave length of the RF electromagnetic wave. As a result, the plasma intensity along the reactor is no longer uniform. Physically, the origin of such a limitation may lie in the fact that the RF wave is distributed according to the beginning of a "standing wave" spacial oscillation within the reactor. See specification, page 2, lines 12-18.

The present invention thus provides an improved capacitively coupled RF plasma reactor for eliminating or notably reducing the electromagnetic non-uniformity in a reactor

designed to process large size substrates (>=0.7m) at RF frequency higher than 13.56 MHz.

(a) <u>Rejection using the combination of Hanada, Shang and Collins</u>

Claims 1, 3, 4 and 6-8 are rejected under 35 U.S.C. § 103(a) as being unpatentable over the combined teachings of Hanada, Shang and Collins. The Examiner noted that Hanada discloses a capacitively coupled RF reactor. The Examiner, however, acknowledges that Hanada fails to teach a "radio frequency generator for frequencies greater than 13.56 MHz and at least one substrate with a largest dimension of at least 0.7m." See May 11, 2006 Final Office Action, page 2, second paragraph (which continues to the top of page 3), and page 3, first paragraph.

Consequently, the Examiner turned to col. 4, lines 26-47, of Collins alleging that it discloses "a capacitively coupled radio frequency plasma reactor using a radio frequency generator which applies frequencies greater than 13.56 MHz." The Examiner thus concluded that in view of the teachings of Collins it would have been obvious at the time the invention was made "for the radio frequency generator of Hanada to apply frequencies greater than 13.56 MHz as taught by Collins et al. since higher frequencies provide commercially viable processing rates and substantial reduction in sheath voltages." See May 11, 2006 Final Office Action, page 3, second paragraph.

Contrary to the Examiner's interpretation, Applicant has recognized that Collins does not disclose a capacitively coupled RF plasma reactor. Instead, Collins discloses a VHF/UHF system where the reactor "itself... is configured in part as a transmission line structure..." See Collins, col. 3, lines 30-32. Simply put, the reactor can be likened to a

widened-up wave duct or hollow conductor with the system cathode 32c (as shown in FIG. 1 of Collins) being described, for example, as a "cylindrical electrode means" (see claim 1 of Collins), and the system anode being described as comprising "sidewalls 12, top wall 13 and/or manifold 27 of the reactor chamber." (see col. 5, lines 9-13). Thus, the reactor described in Collins cannot be characterized as a capacitively coupled (or parallel plate) RF plasma reactor.

It is well settled that the initial burden of establishing obviousness rests on the Examiner. To establish obviousness, the teachings of the prior art must suggest the claimed subject matter to a person of ordinary skill in the art with a reasonable likelihood of success of achieving the suggested invention.

Since Collins discloses that high frequency VHF/UHF energy has not been used with any degree of commercial success during plasma processing, due to, e.g., stringent system design requirements for efficient coupling of the energy to the reactor chamber (see Collins, col. 2, lines 49-59), those of ordinary skill in the art would not be motivated to use a high frequency generator that applies frequencies greater than 13.56 MHz in Hanada. If reducing the voltage seen by the wafers during plasma processing cannot be accomplished in a commercially viable manner simply by increasing the energy, those skilled in the art would not be motivated to apply frequencies greater than 13.56 MHz in the plasma reactor of Hanada based on principles developed from an entirely different type of reactor, let alone hold any expectation that the combination proposed by the Examiner would be successful, i.e., in providing "commercially viable processing rates and substantial reduction in sheath voltages." (see May 11, 2006 Final Office Action, page 3, second paragraph).

The Examiner then turned to col. 5, lines 58-63, of Shang alleging that it teaches "a plasma reactor for processing a substrate for flat panel displays with a largest dimension up to 1m." The Examiner concluded that in view of the teachings of Shang it would have been obvious at the time the invention was made "to provide the apparatus of Hanada with a substrate having a largest dimension up to 1m in order to process substrates for flat panel displays..." See May 11, 2006 Final Office Action, page 3, third paragraph.

Applicant has recognized that Shang merely discloses an apparatus and method for holding a substrate. According to Shang, the substrate (165) is placed in the plasma chamber and supported by lift pins (171). The lift pins retract and lower substrate until the bottom surface (173) of the substrate is at a predetermined separation distance above the top surface (23) of the support layer (22). Plate-charge inducing plasma is then ignited to provide the bottom surface of the substrate with a positive charge and the top surface of the support layer with a negative charge. This way, when the substrate is lowered onto the support layer, the substrate is held substantially flat against the support layer by electrostatic attraction. The purpose of Shang's invention is therefore to provide a mechanical arrangement for lowering the substrate and holding the substrate substantially flat against the support layer. See Shang, col. 6, lines 18-50, and col. 7, lines 9-26.

Since the only purpose of the plate-charge inducing plasma is to create electrostatic charges on the surfaces of the substrates and the support layer, uniformity in the plasma density is not necessary. Consequently, even though Shang discloses processing substrate as large as 1 square meter, there is no motivation to scale up the plasma chamber of Hanada to process a substrate with a largest dimension of at least 0.7m because those of ordinary skill in the art at the time of filing the present application would

expect that the plasma intensity along the reactor would no longer be uniform under the processing conditions specified in the claimed invention. Even if, *arguendo*, that motivation for scaling up the plasma chamber of Hanada exists, those of ordinary skill in the art still would not have any reasonable expectation of success in eliminating or reducing the non-uniformities in the plasma density because at the time of filing the present application those of ordinary skill in the art would have known the influence of the "standing wave" effect on plasma discharge and both Hanada and Shang fail to offer any suggestion to compensate for plasma non-uniformity once the reactor has been scaled up to process large-size substrates (>=0.7m) at high frequencies (i.e., higher than 13.56 MHz).

For the foregoing reasons, Applicant respectfully submits that the Examiner's rejection of claims 1, 3, 4 and 6-8 as unpatentably obvious under 35 U.S.C. § 103(a) is in error and should be withdrawn. Such action is respectfully solicited.

(b) Rejection using the combination of Hanada, Shang and Sato

Claims 1, 3, 4 and 6-8 are rejected under 35 U.S.C. § 103(a) as being unpatentable over the combined teachings of Hanada, Shang and Sato. The Examiner noted that Hanada discloses a capacitively coupled RF reactor. The Examiner, however, acknowledges that Hanada fails to teach a "radio frequency generator for frequencies greater than 13.56 MHz and at least one substrate with a largest dimension of at least 0.7m." See May 11, 2006 Final Office Action, page 5, fifth paragraph (which continues to the top of page 3), and page 6, first paragraph.

Consequently, the Examiner turned to col. 2, lines 37-65, and col. 4, line 40, to col. 5, line 40, of Sato alleging that it discloses "a capacitively couple radio frequency plasma

reactor designed to use a radio frequency generator which applies frequencies greater than 13.56 MHz (30-300MHz)(col. 2, lines 53-56) and that process a substrate with a largest dimension of at least 0.7m (1m)(col. 2, lines 37-44)..." The Examiner thus concluded that in view of the teachings of Sato it would have been obvious at the time the invention was made "to design the reactor of Hanada to apply frequencies greater than 13.56 MHz and accommodate at least one substrate with a largest dimension of at least 0.7m as taught by Sato et al. since there is a growing demand in industry to uniformly process large substrates at high frequencies with a reduced weight, dimension, and cost to the overall apparatus." See May 11, 2006 Final Office Action, page 6, second paragraph.

Applicant has recognized that Sato clearly focuses on solving the problem of electrical connection, impedance matching, and so forth. The structure and arrangement of the plasma reactor of Sato are described, for example, in col. 3, lines 38-32. For certain ratios of length of lines and diameters of the electrodes, the various equations developed by Sato provide solutions for effective coupling of RF energy into the system. However, Sato also fails to offer any suggestions for compensating for the non-uniformities in the plasma density when utilizing RF frequencies higher than 13.56 MHz to process large size substrates (>=0.7m). As far as Sato is concerned, plasma non-uniformities do not exist because Sato may have only applied their knowledge to plasma reactors that process small size wafers, e.g., 8 inches (Sato, col. 10, lines 12-13). As a result, Sato may not have had the occasion to observe the non-uniformities in the plasma density resulting from the influence of "standing wave" effect. Therefore, at the time of filing the present application, those of ordinary skill in the art would have found Sato's teaching or

suggestion of processing large substrates with a largest dimension of at least 0.7m at frequencies greater than 13.56 MHz to be non-enabling because they would appreciate that non-uniformities in the plasma density (which Sato fails to recognize) would result and the scaled-up system would no longer be commercially viable or useful, let alone capable of uniformly processing large substrates to meet growing demand, as suggested by the Examiner.

The Examiner also turned to col. 5, lines 58-63, of Shang alleging that it teaches "a plasma reactor for processing a substrate for flat panel displays with a largest dimension up to 1m." The Examiner thus concluded that in view of the teachings of Shang it would have been obvious at the time the invention was made "to provide the apparatus of Hanada with a substrate having a largest dimension up to 1m in order to process substrates for flat panel displays..." See May 11, 2006 Final Office Action, page 7, first paragraph.

As discussed previously, Shang merely discloses an apparatus and method for holding a substrate. According to Shang, the substrate (165) is placed in the plasma chamber and supported by lift pins (171). The lift pins retract and lower substrate until the bottom surface (173) of the substrate is at a predetermined separation distance above the top surface (23) of the support layer (22). Plate-charge inducing plasma is then ignited to provide the bottom surface of the substrate with a positive charge and the top surface of the support layer with a negative charge. This way, when the substrate is lowered onto the support layer, the substrate is held substantially flat against the support layer by electrostatic attraction. The purpose of Shang's invention is therefore to provide a mechanical arrangement for lowering the substrate and holding the substrate substantially

flat against the support layer. Shang, col. 6, lines 18-50, and col. 7, lines 9-26.

Since the only purpose of the plate-charge inducing plasma is to create electrostatic charges on the surfaces of the substrates and the support layer, uniformity in the plasma density is not necessary. Consequently, even though Shang discloses processing substrate as large as 1 square meter, there is no motivation to scale up the plasma chamber of Hanada to process a substrate with a largest dimension of at least 0.7m because those of ordinary skill in the art at the time of filing the present application would expect that the plasma intensity along the reactor would no longer be uniform under the conditions recited in the claimed invention. Even if, *arguendo*, that motivation for scaling up the plasma chamber of Hanada exists, those of ordinary skill in the art still would not have any reasonable expectation of success in eliminating or reducing the non-uniformities in the plasma density because at the time of filing the present application those of ordinary skill in the art would have known the influence of the "standing wave" effect on plasma discharge and both Hanada and Shang fail to offer any suggestion to compensate for plasma non-uniformity once the reactor has been scaled up to process large-size substrates (>=0.7m) at high frequencies (i.e., higher than 13.56 MHz). Simply put, those of ordinary skill in the art at the filing of the present application would have expected non-uniformities in the plasma density from, e.g., "standing wave" effect once the reactor is scaled-up (e.g., to match the conditions specified in the claimed invention). Therefore, without any suggestions for compensating for the non-uniformities in the plasma density in a scaled up reactor designed to process large-size substrates (>=0.7m) at high frequencies (i.e., higher than 13.56 MHz), those of ordinary skill in the art would not be motivated to combine the references cited by the Examiner and/or have any reasonable

expectation that the combination proposed by the Examiner would be successful absent any guidance for dealing with the causes of plasma non-uniformity (such as "standing wave" effect) in the scaled-up plasma reactors.

For the foregoing reasons, Applicant respectfully submits that the Examiner's rejection of claims 1, 3, 4 and 6-8 as unpatentably obvious under 35 U.S.C. § 103(a) is in error and should be withdrawn. Such action is respectfully solicited.

Respectfully submitted,

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CLAIMS APPENDIX

Claim 1 (previously presented): A capacitively coupled radiofrequency plasma reactor (1, 20) comprising:

at least two electrically conductive electrodes (3, 5) spaced from each other, each electrode having an external surface (3a, 5a),

an internal process space (13) enclosed between the electrodes (3, 5),

gas providing means (7) for providing the internal process space (13) with a reactive gas,

at least one radiofrequency generator (9) for frequencies greater than 13.56 MHz connected to at least one of the electrodes (3, 5), at a connection location (9a), for generating a plasma discharge in the process space (13),

means (8) to evacuate the reactive gas from the reactor,

at least one substrate (15) with a largest dimension of at least 0.7 m, defining one boundary of the internal process space, to be exposed to the processing action of the plasma discharge, said at least one substrate (15) extending along a general surface (15a) and being arranged between the electrodes (3, 5),

characterized in that said plasma reactor (1, 20) further comprises at least one dielectric layer (11) have at least one non-planar external surface and extending outside the internal process space, the dielectric layer being a capacitor that is electrically in series with said substrate (15) and the plasma, said dielectric layer (11) having capacitance per unit surface values which are not uniform along at least one direction of said general surface (15a), for generating a given distribution profile, for compensating a process in a

non-uniform manner along said general surface (15a) in the reactor.

Claim 2 (withdrawn): The reactor of claim 1, including:

an additional radiofrequency generator (93) connected to at least one of the electrodes (3, 45), for increasing the ion bombardment on said substrate.

Claim 3 (previously presented): The reactor of claim 1, characterized in that said dielectric layer has a thickness (e_1) along a direction perpendicular to the general surface of the substrate, said thickness being non uniform along said dielectric layer, so that the reactor has a location-dependent capacitance per unit surface values along the general surface.

Claim 4 (previously presented): The reactor according to claim 3, characterized in that:

the said dielectric layer (11) is the thickest in front of the location in the process space (13) which is the furthest away from said connection location (9a) where the radiofrequency generator is connected to said at least one electrode, and

said thickness decreases from said process space location as the distance between the process space location and the connection location on the corresponding electrode decreases.

Claim 5 (canceled).

Claim 6 (previously presented): The reactor according to claim 1, characterized in that at least one of said electrodes has a non planar-shaped surface facing the substrate.

Claim 7 (previously presented): The reactor according to claim 1, characterized in that:

said one dielectric layer is locally delimited by a surface of one of said electrodes (5a, 41b, 51b), and

said delimitation surface of said one electrode is curved.

Claim 8 (previously presented): The reactor according to claim 1, characterized in that said dielectric layer comprises at least one of a solid dielectric layer and a gaseous dielectric layer, or a combination of the both mentioned.

Claim 9 (withdrawn): The reactor according to claim 1, characterized in that the at least one substrate comprises a plate having a non planar-shaped external surface.

Claim 10 (withdrawn): The reactor according to claim 1, characterized in that the at least one substrate (65) has a curved shape.

Claim 11 (withdrawn): The reactor according to claim 1, characterized in that spacing members are arranged between said substrate (35', 65) and one of the electrodes (25, 45), said spacing members having elongations being non uniform.

Claim 12 (withdrawn): The reactor according to claim 11, characterized in that the spacing members (89) at the non-substrate-end being surrounded by a space (91), for at least partially compensating the electromagnetic perturbation induced by the contact between the spacing member and the substrate.

Claims 13-15 (canceled).

EVIDENCE APPENDIX

Not applicable.

RELATED PROCEEDINGS APPENDIX

Not applicable.